

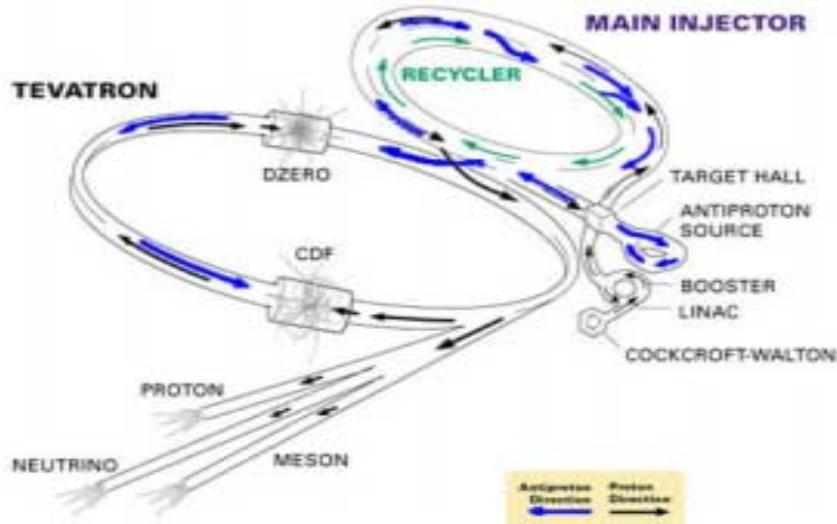


# QCD Results at CDF

- ✓ Inclusive Jet Cross Section
- ✓ Dijet Mass
- ✓ Jet Shapes
- ✓ Diffractive Dijets



# Tevatron Collider



- inst. lum.  $2\text{-}3 \times 10^{31} \text{ cm}^{-2}\text{sec}^{-1}$
- delivered  $4\text{-}7 \text{ pb}^{-1}$  per week
- goal:  $12 \text{ pb}^{-1}$  per week

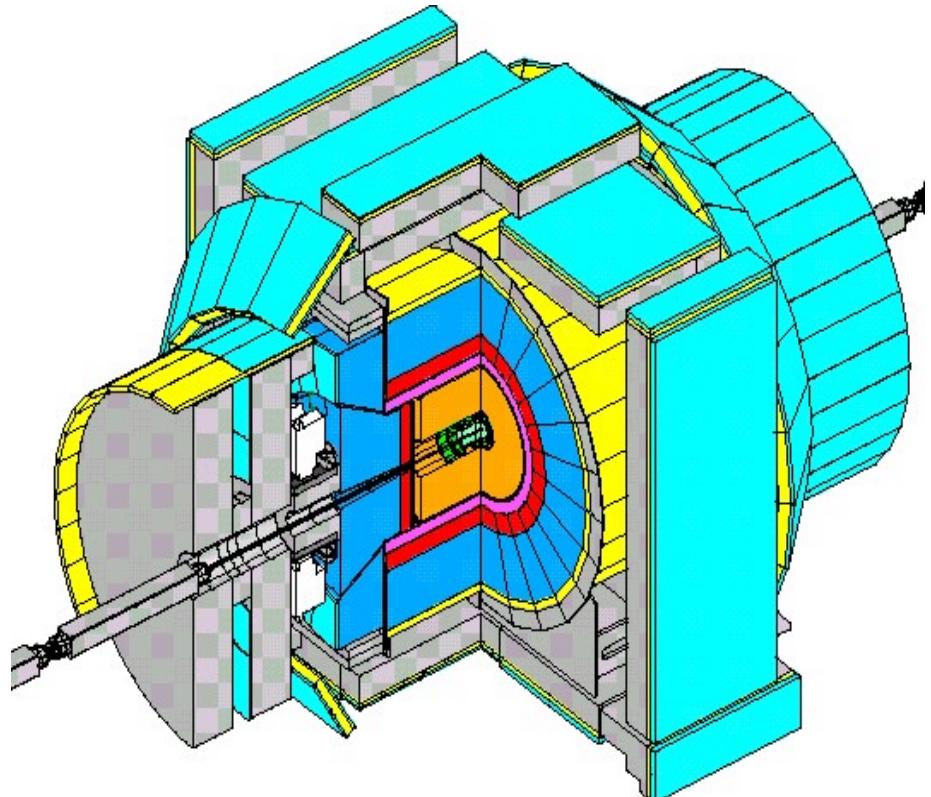
- C.M. energy  $1.96 \text{ TeV}$
- $396 \text{ nsec}$  bunch spacing





# CDF II Detector

- Tracking
  - ✓ Silicon
  - ✓ Central Outer Tracker
- Time of Flight
- Expanded Muon Coverage
- Endplug Calorimeter
- Forward Detectors
- Trigger
  - ✓ Tracks @ L1
  - ✓ Silicon Tracks @ L2
- DAQ (132 ns)



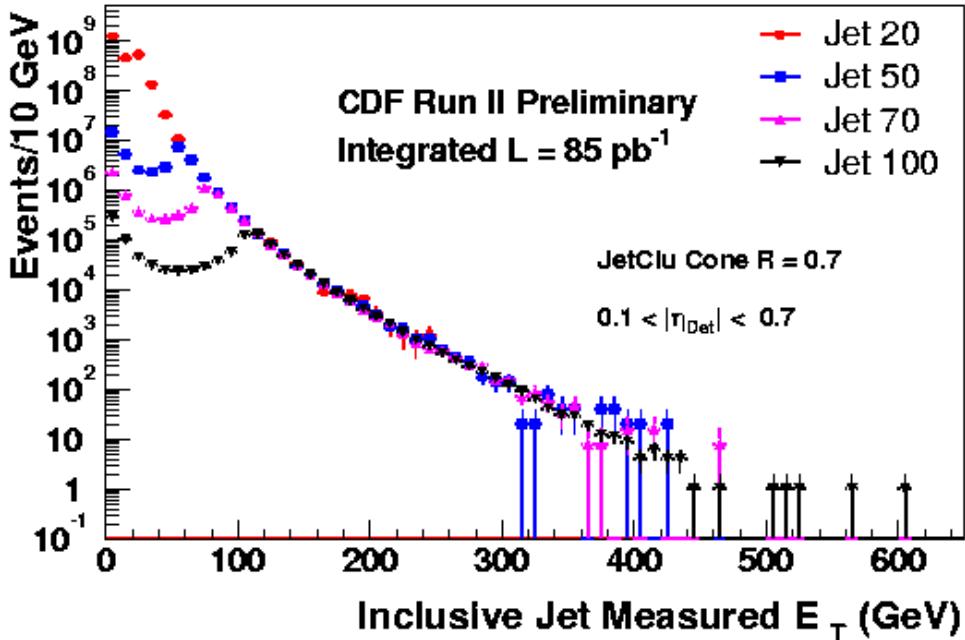


# QCD at the Tevatron

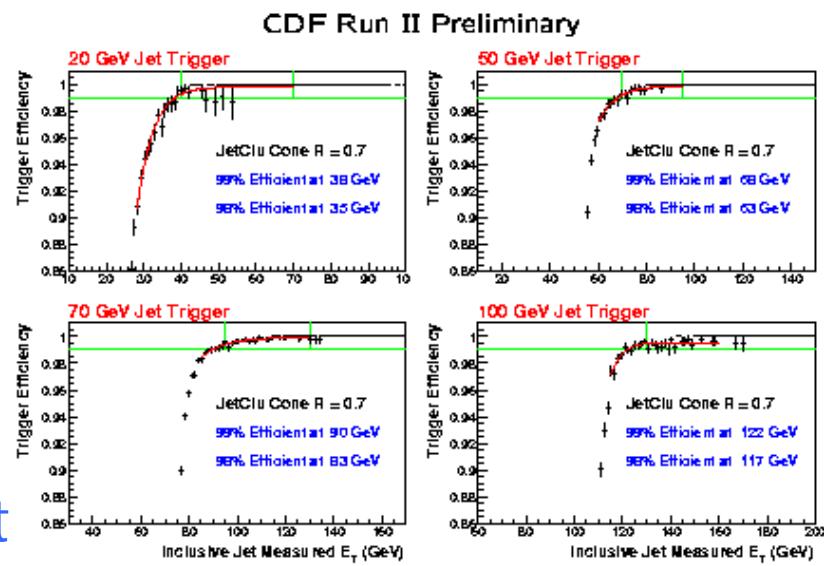
- Tevatron Collider is a tool for precision tests of QCD
  - Compare to QCD predictions
  - Probe to small distance scales
  - Look for new physics
- 
- Higher center-of-mass energy than Run I  
     $\Rightarrow \sqrt{s} = 1.96 \text{ TeV}$
  - Higher jet cross section



# Jet $E_T$ Spectrum



Excess at high jet  $E_T$  in Run I

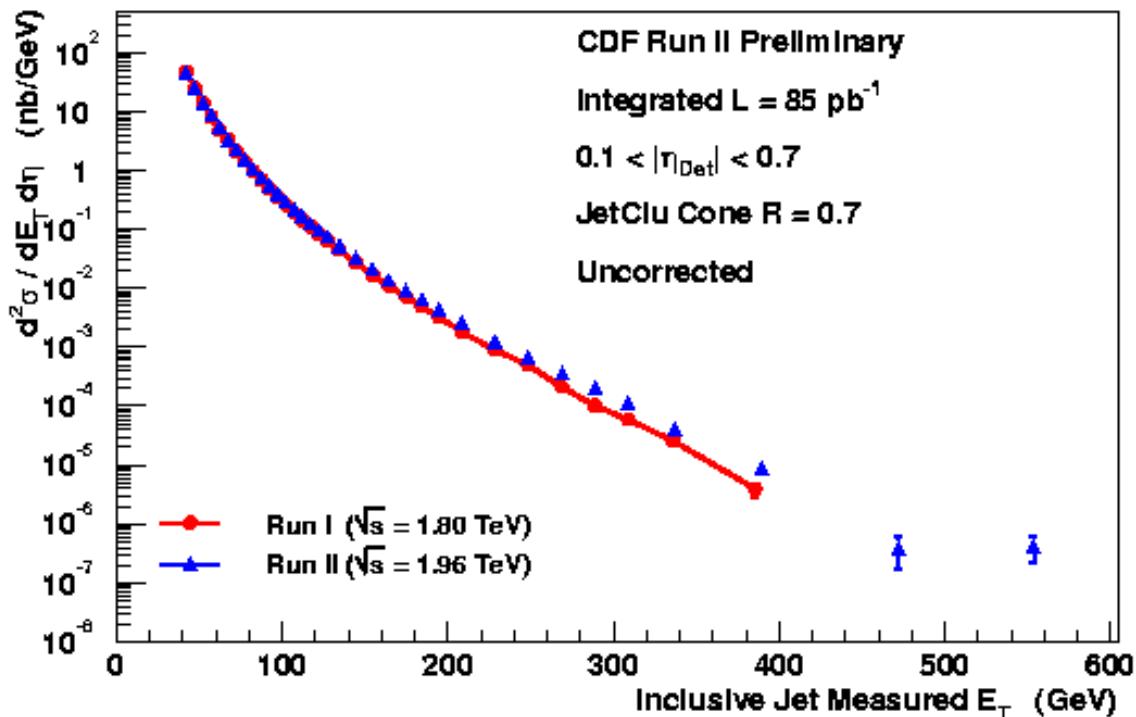


- Use cone algorithm
- Different  $E_T$  triggers
- Use data when trigger is 99 % efficient



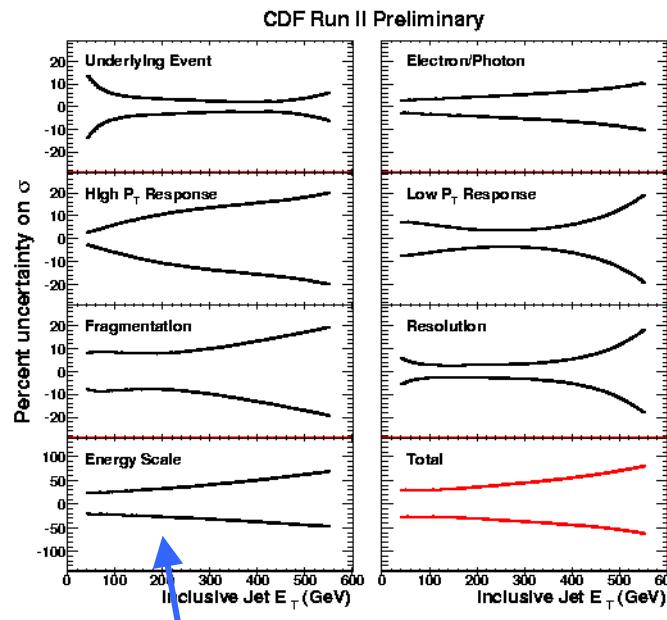
# Inclusive Jet Cross Section

Continuous spectrum to higher Jet  $E_T$



Run II data extends Run I results by  $\sim 150 \text{ GeV}$

Systematic uncertainties

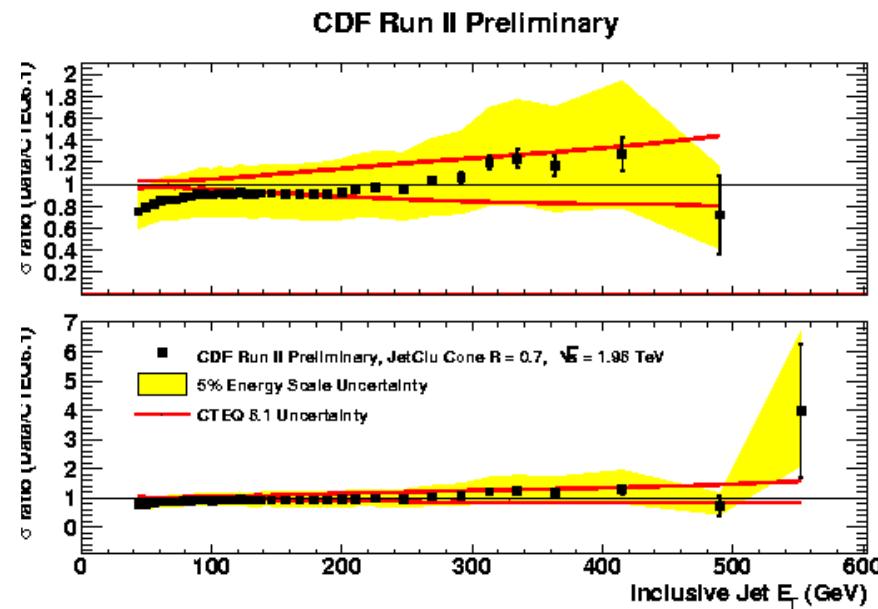
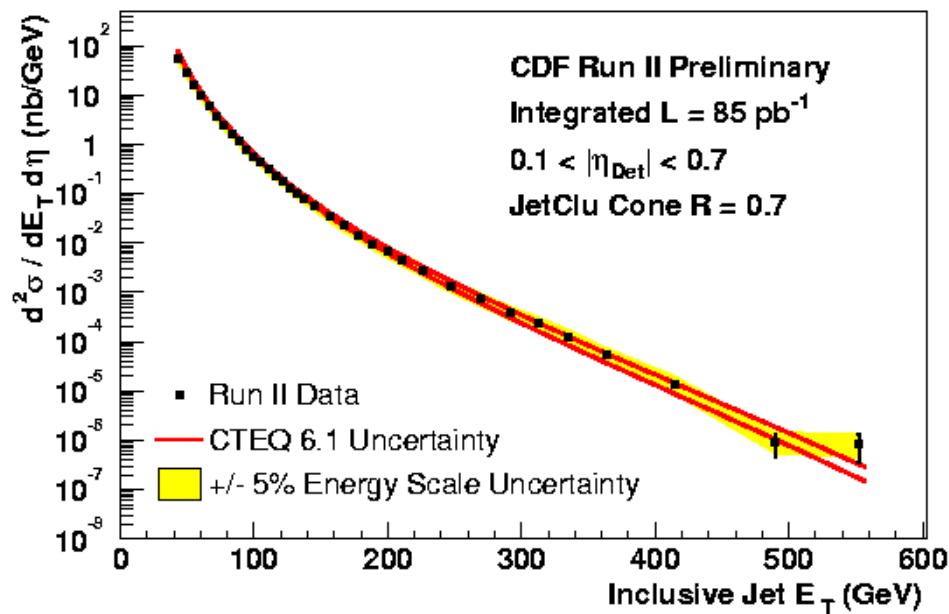


Largest uncertainty  
(~ 5 %)



# Cross Section Fit

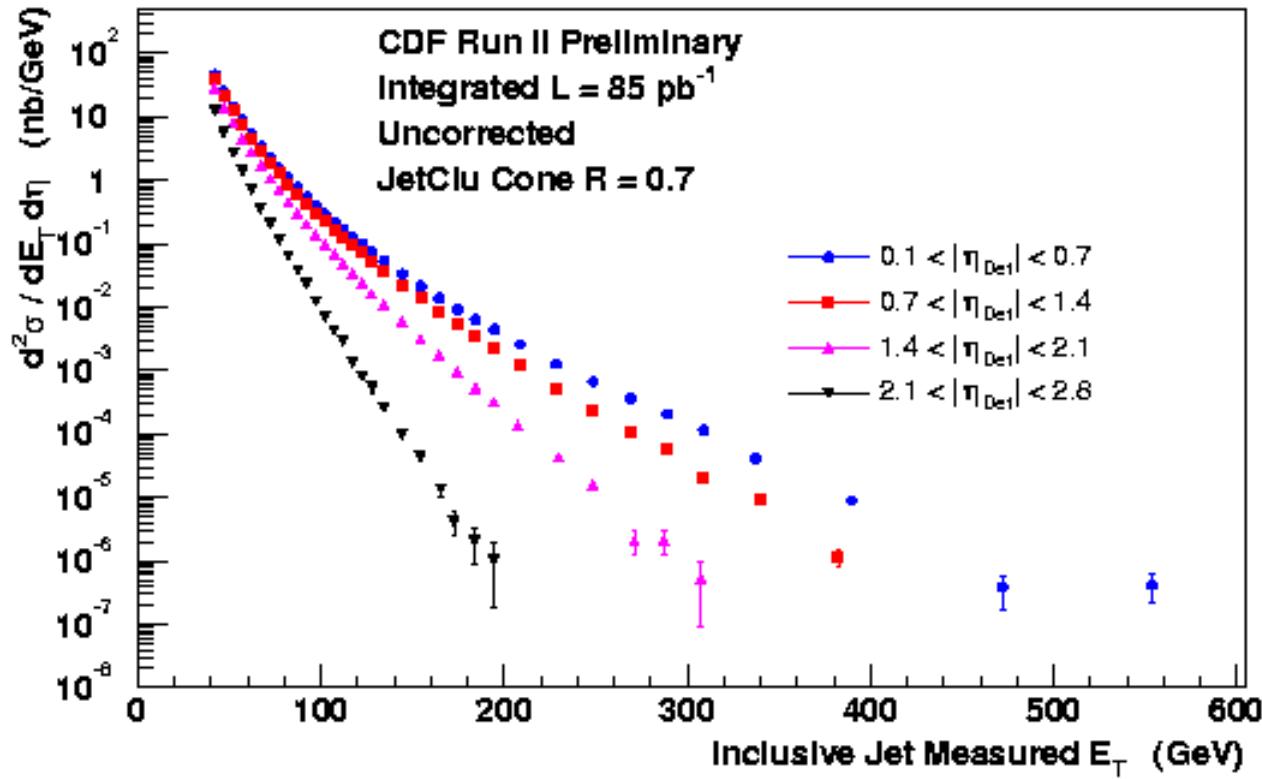
Best fit to central jet cross section provided by CTEQ 6.1



Gluon distribution has large uncertainty in high  $x$  region



# Jet Cross Section vs $\eta$

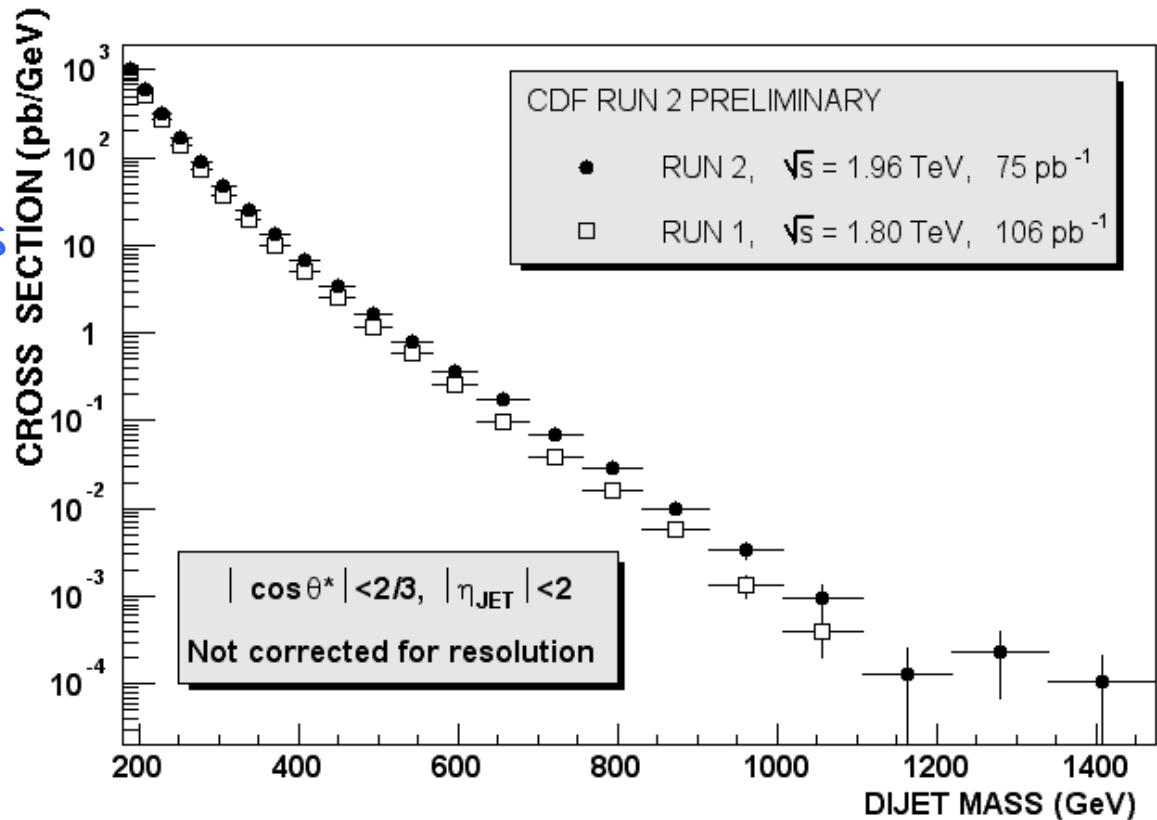


- QCD sub-processes at small angles
- Central jets are more likely to signal new physics (hep-ph 0303013)



# Dijet Mass

- Two highest  $E_T$  jets
- Search for resonances



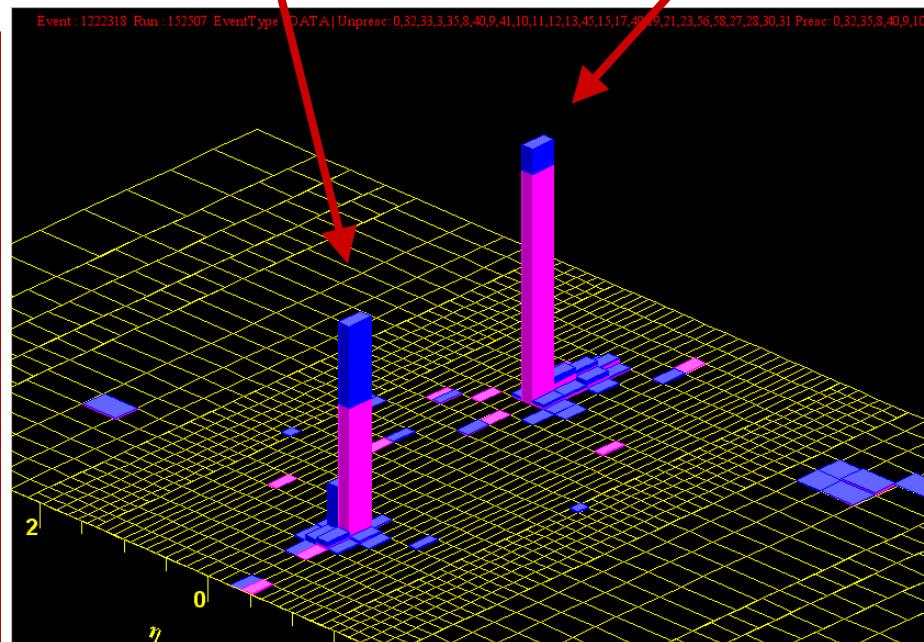
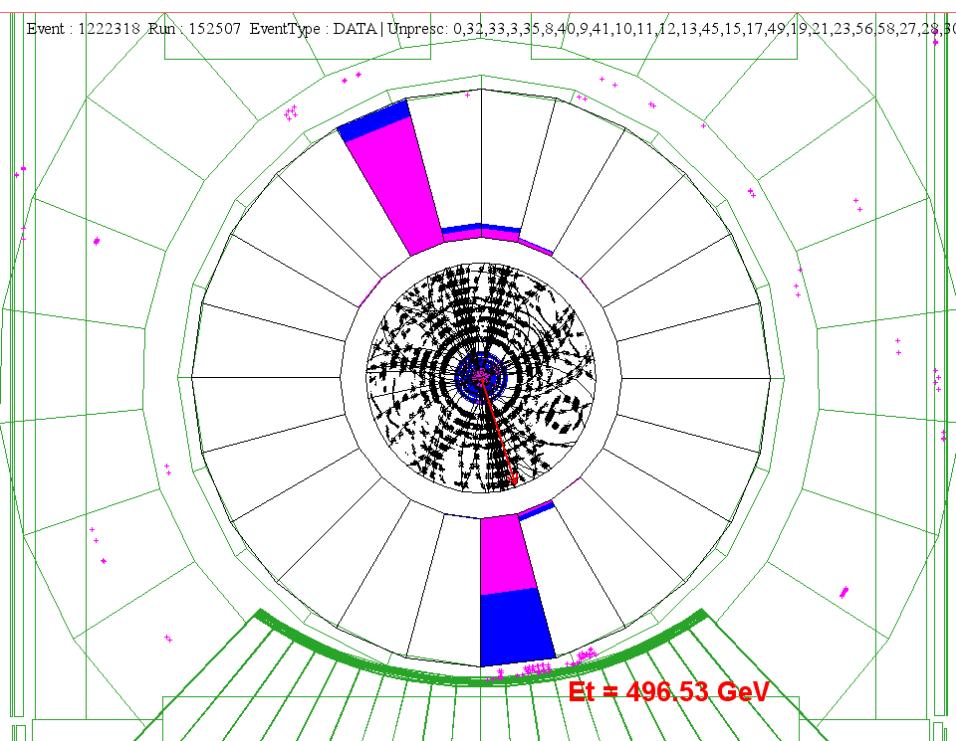
⇒ Larger dijet mass events than in Run I



# High Dijet Mass Event

Run 152507 event 1222318  
Dijet Mass = 1364 GeV (corr)

<u>Jet 2</u> $E_T = 633 \text{ GeV (corr)}$ $\eta_{\text{det}} = -0.30$	<u>Jet 1</u> $E_T = 666 \text{ GeV (corr)}$ $\eta_{\text{det}} = 0.31$
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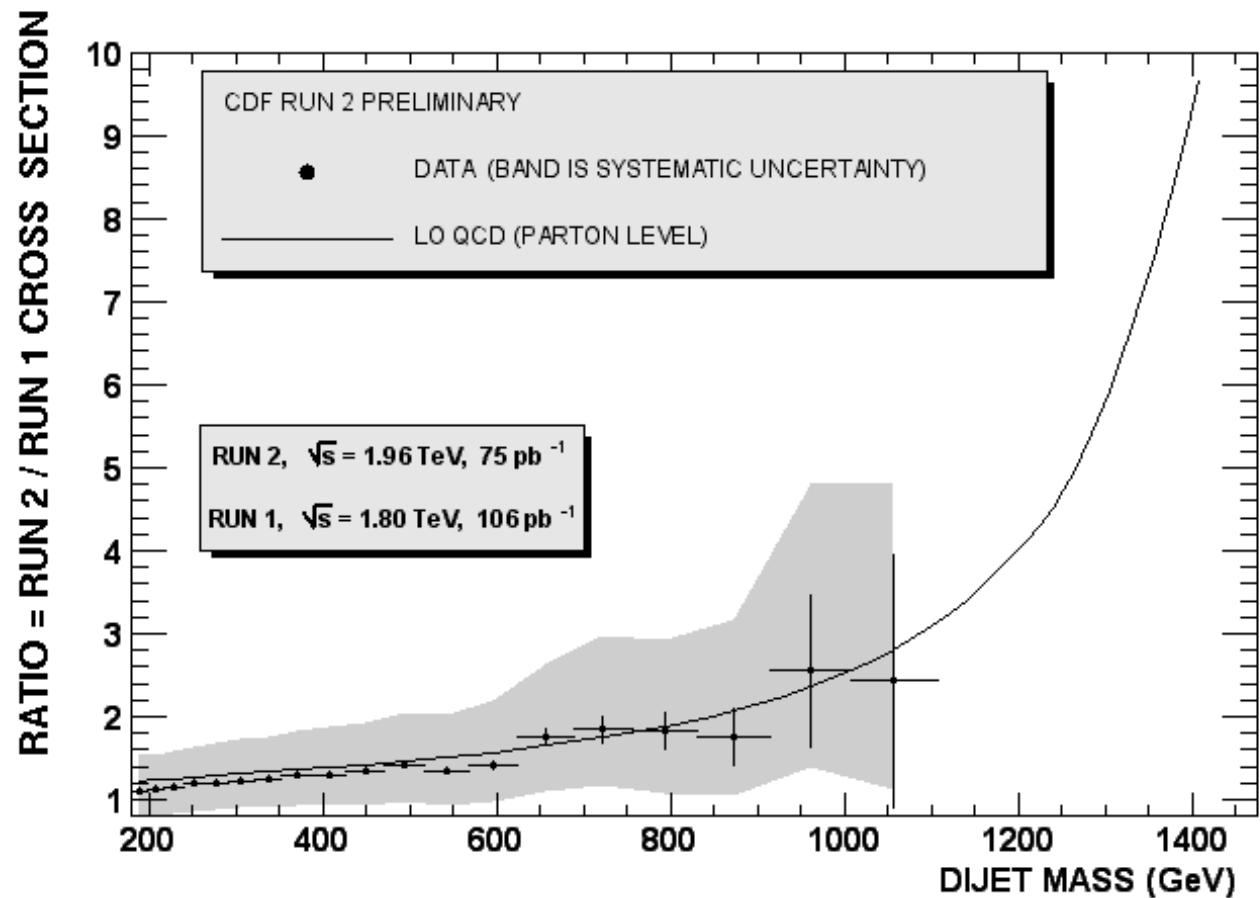


CDF Run 2 Preliminary



# Dijet Mass Ratio: Run II/Run I

Higher jet cross section than Run I



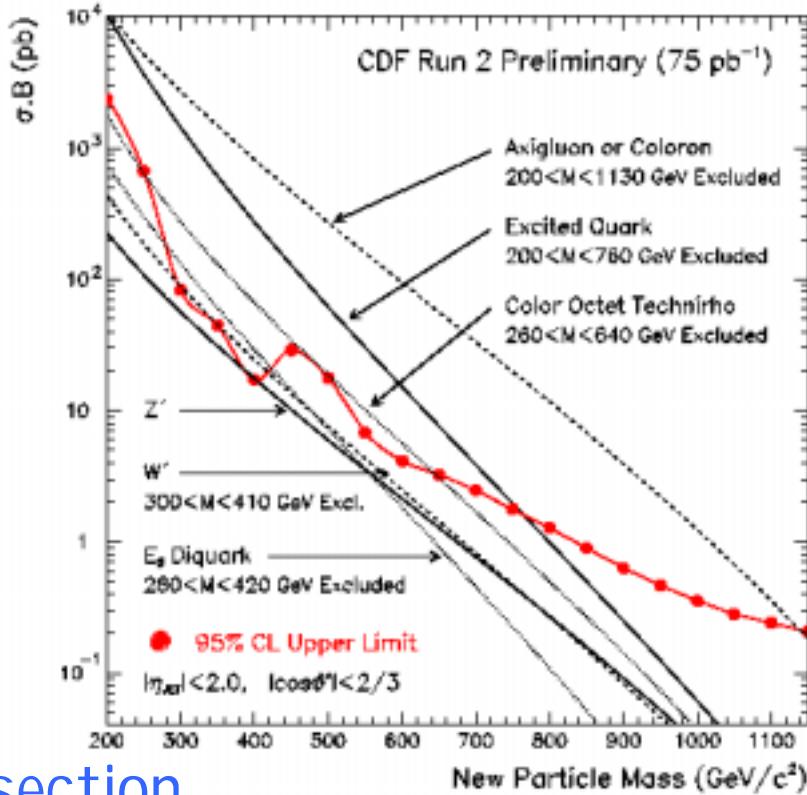
⇒ ratio agrees with theory to ~ 10 % in rate (~ 2 % in energy scale)



# Limits on New Particles

Search for new particles decaying to dijets.

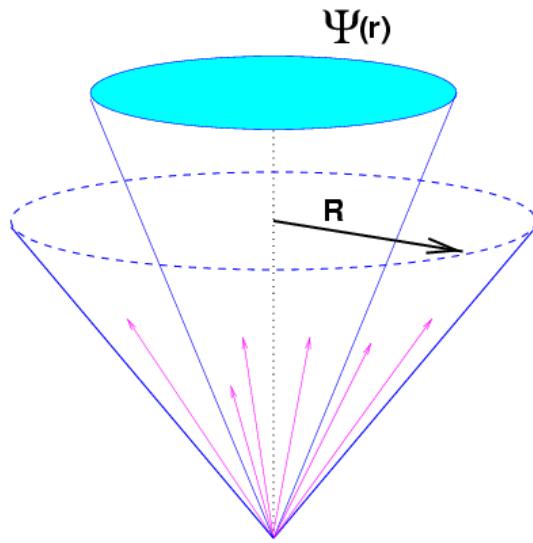
- Fit data to background plus a narrow resonance
- Calculate cross section
- Find 95 % CL upper limit
- Compare with theory



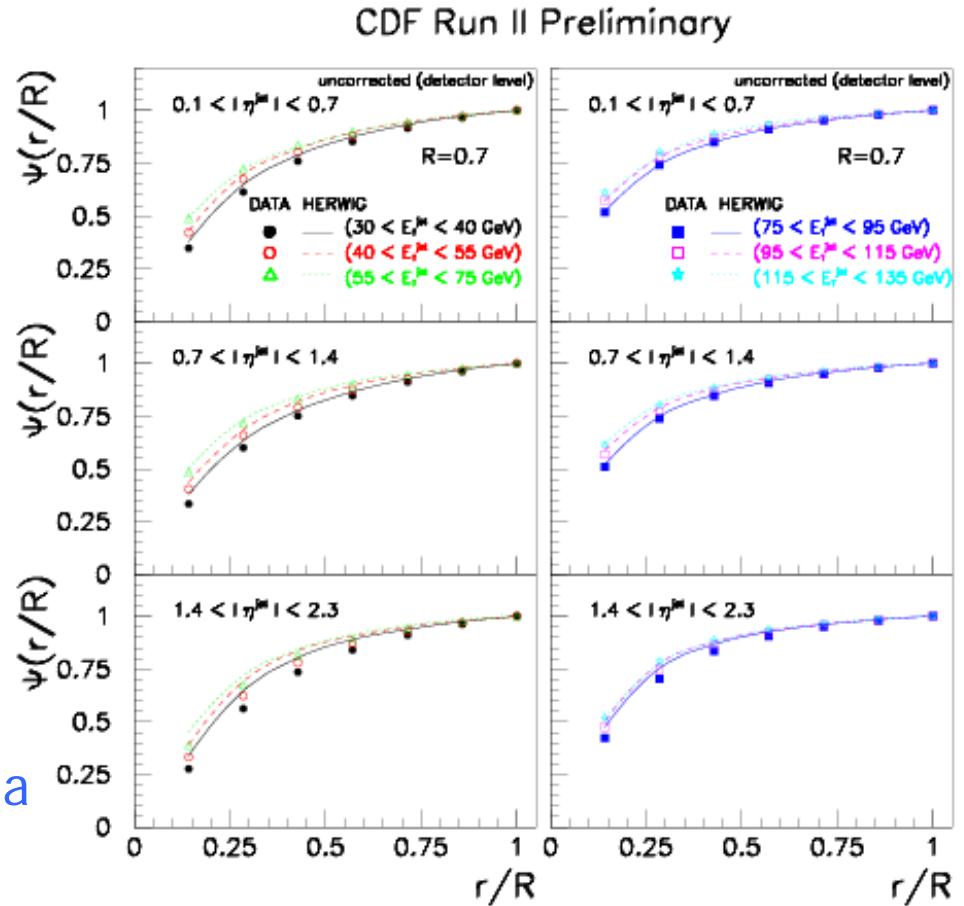
⇒ set upper limits on cross section



# Jet Shapes

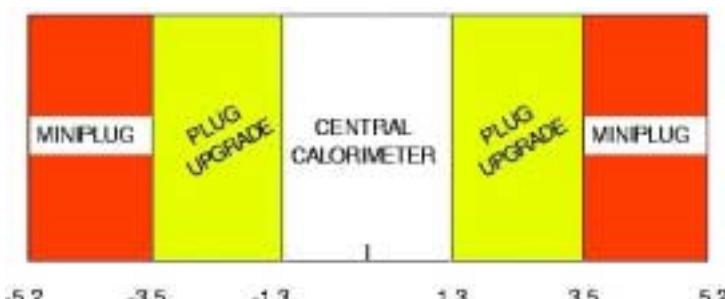
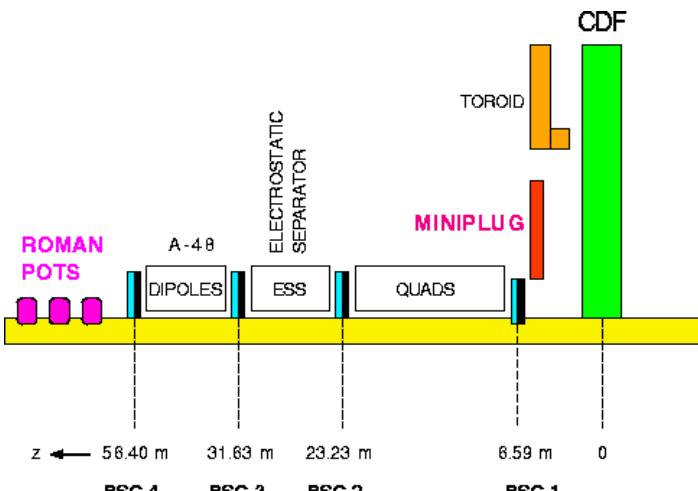


- Jets narrow at high  $E_T$
- Herwig/Pythia agree well with data

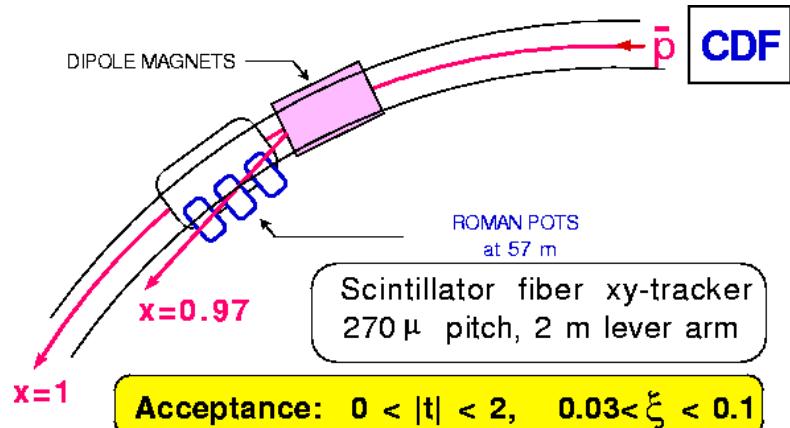




# Forward Physics



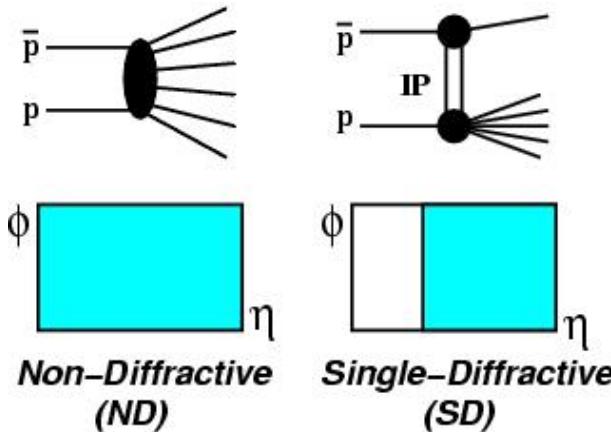
$\eta \longrightarrow$



- Hard Single Diffraction
- Double Pomeron Exchange



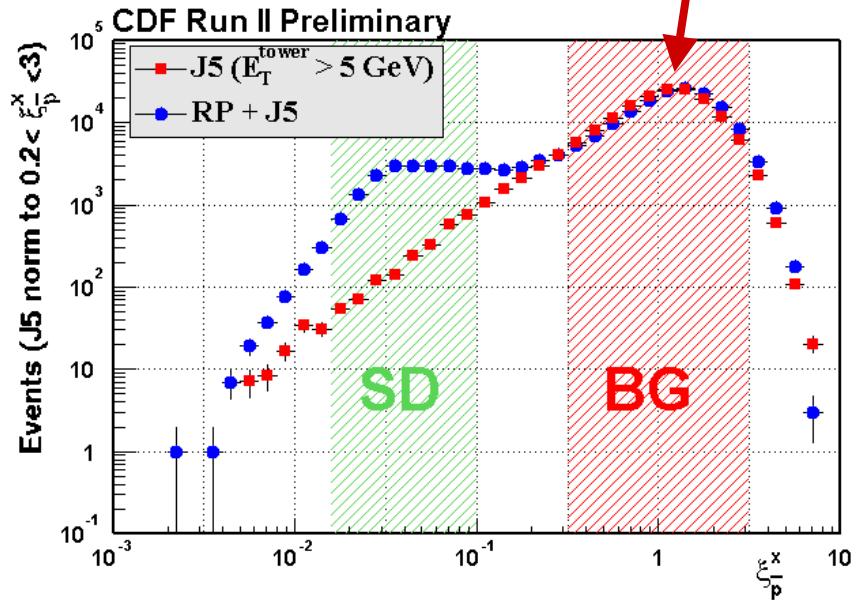
# Diffractive Dijets



Measure  $\xi$  ( $\bar{p}$  momentum loss fraction)  
from calorimeter information

- Compare diffractive events to ND
- Measure diffractive structure function from  $R_{SD/ND}$  vs  $x_{Bj}$

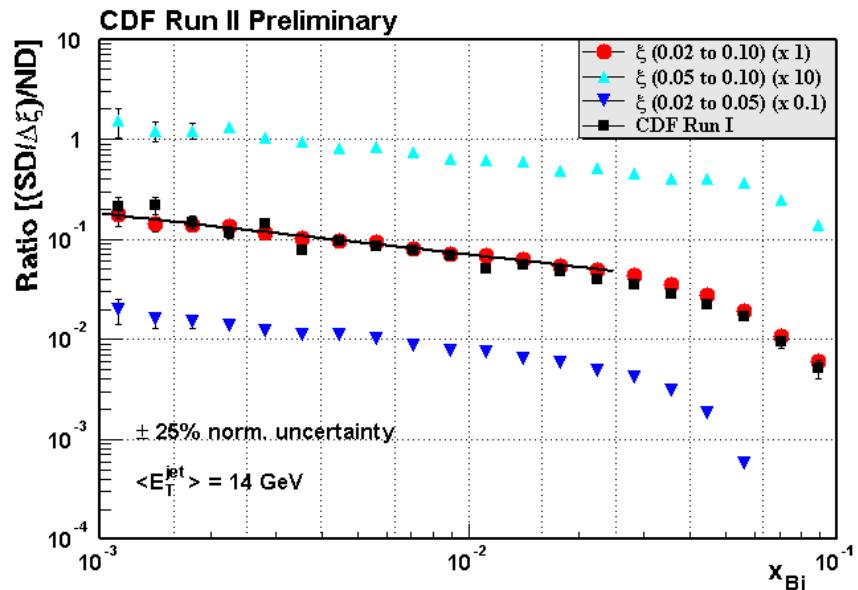
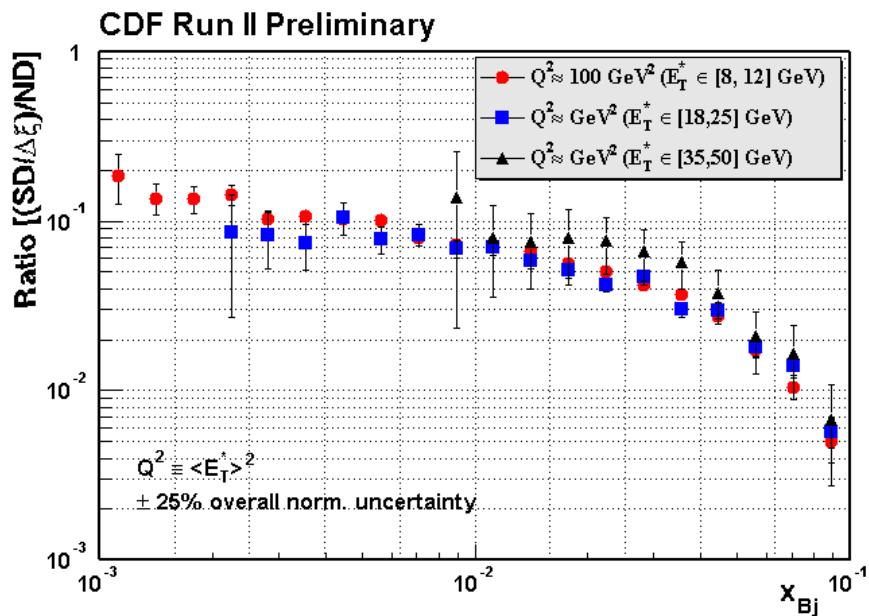
overlap events





# Ratio of SD/ND Events

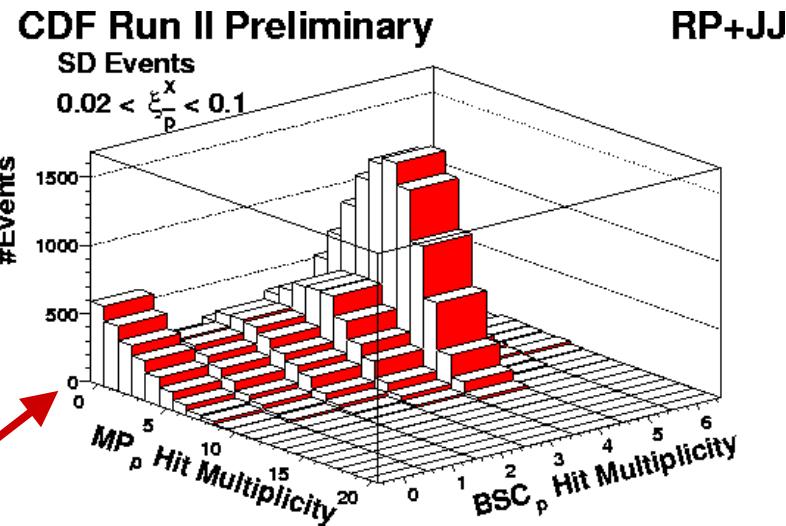
Ratio is independent of  $\xi$  interval



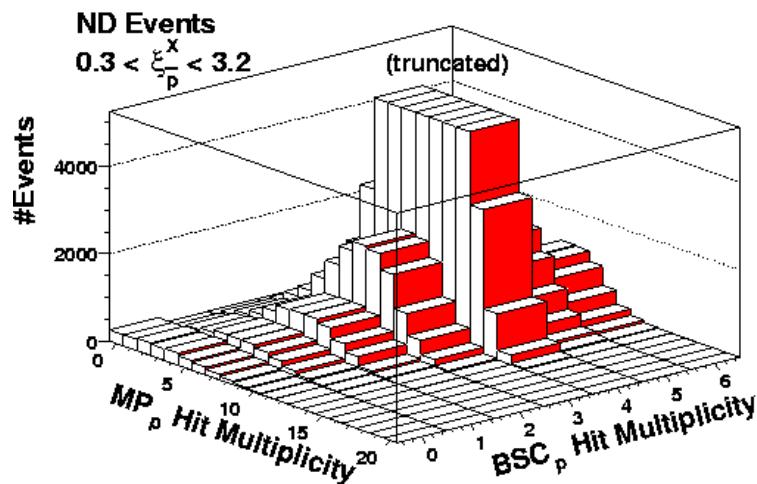
Ratio is independent of  $Q^2$



# Proton-Side Multiplicity

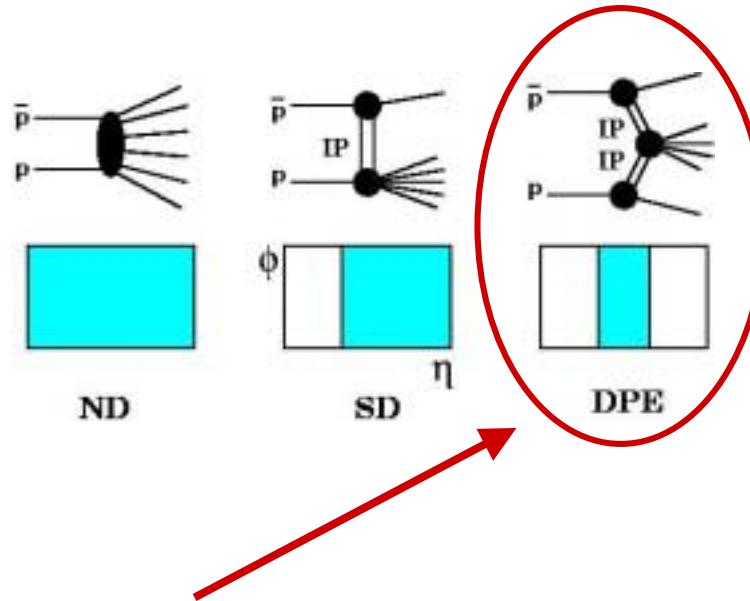


(0,0) bin





# DPE Enhanced Sample

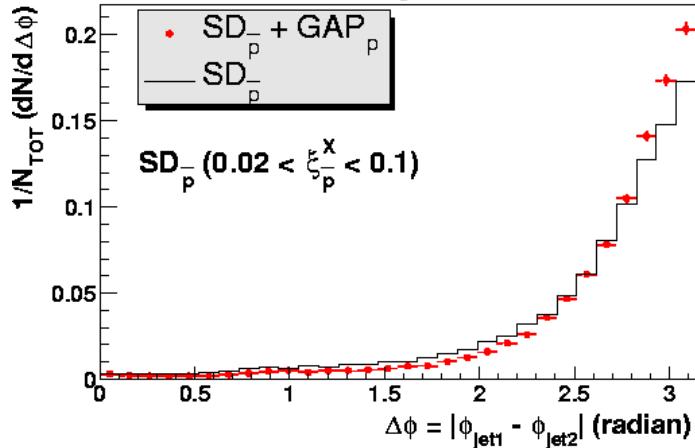


- Use dedicated DPE trigger (RP+J5+GapE)
- (0,0) bin  $\Rightarrow$  ~ 16,000 events (in Run I: ~ 100 evts)

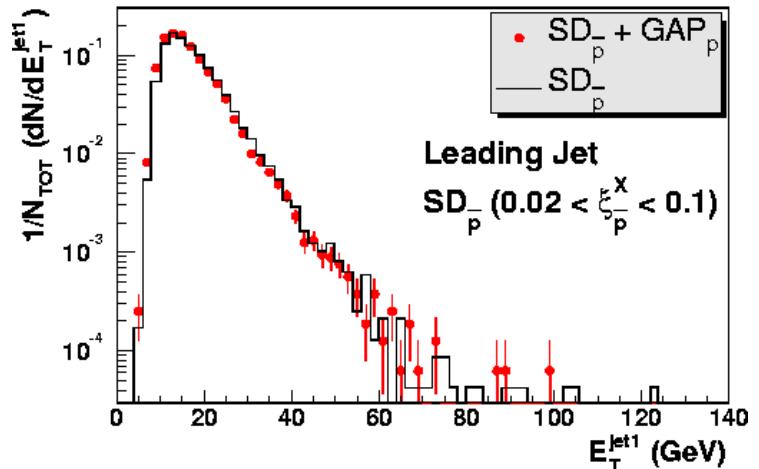


# DPE: Kinematics

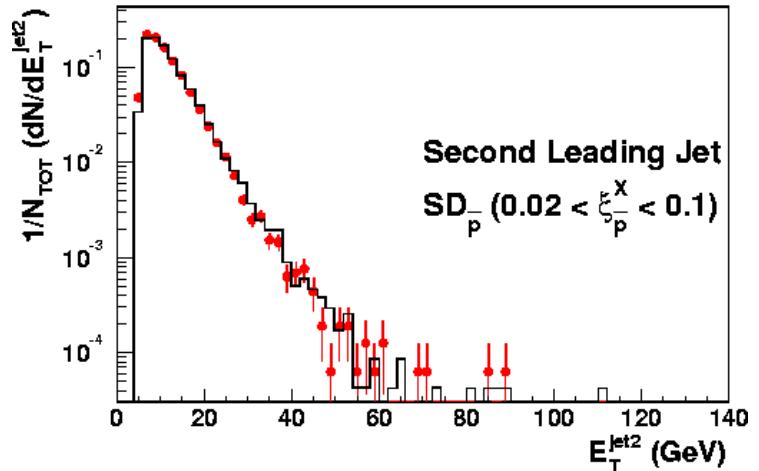
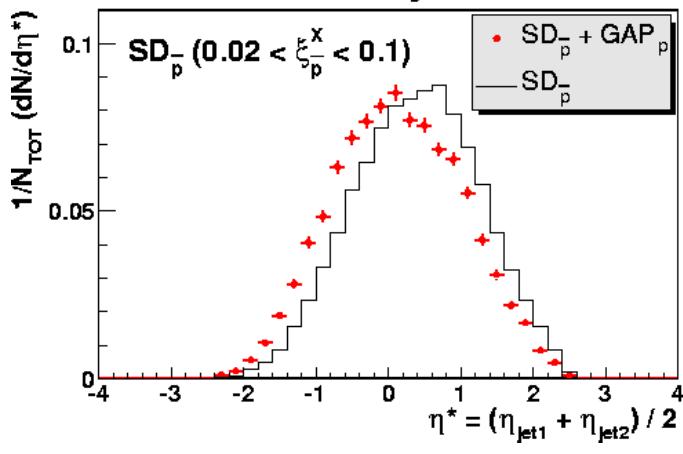
CDF Run II Preliminary



CDF Run II Preliminary



CDF Run II Preliminary





# Summary

- Inclusive jet cross section extends beyond 550 GeV
- Dijet mass up event up to 1364 GeV
- First exclusion of new particle with mass  $> 1 \text{ TeV}$
- Preliminary diffractive results show no  $Q^2$  dependence in SD/ND

Run II analyses are well underway !



# Backup Slides

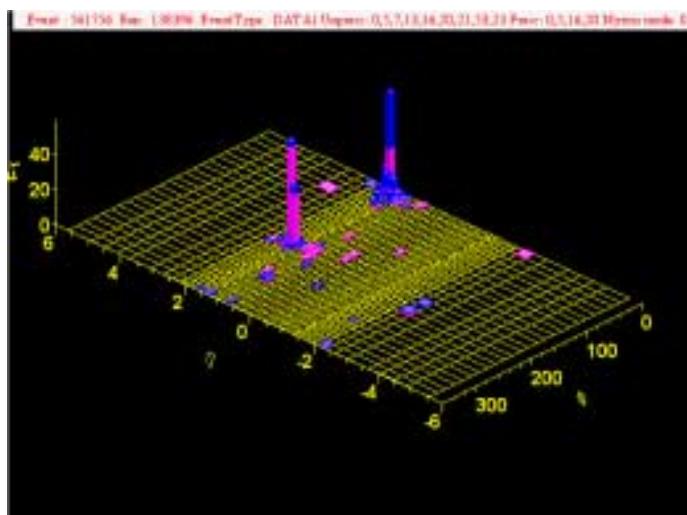
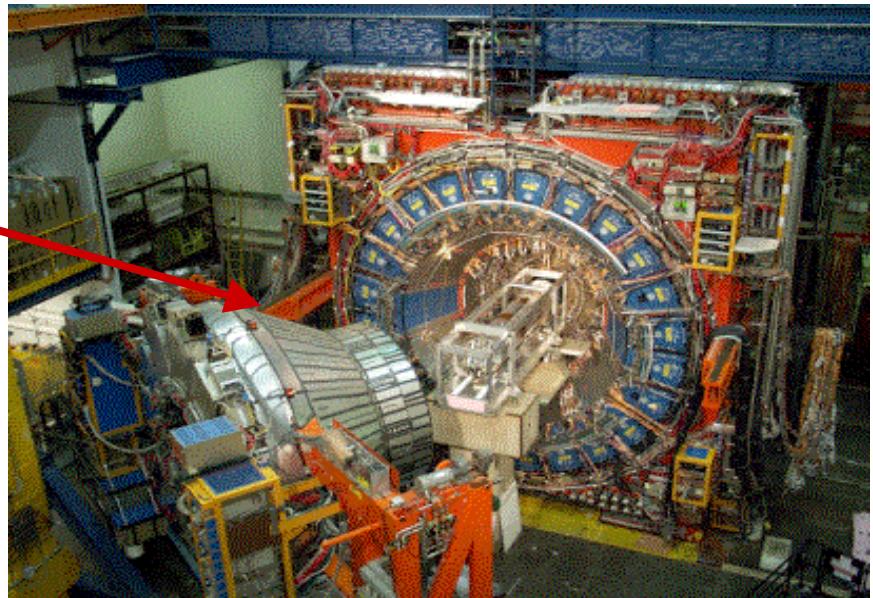
...TO FOLLOW...



# New Plug Calorimeter

Scintillator + lead/steel  
(replaces gas detector)

Full coverage up to  $|\eta| = 3.5$

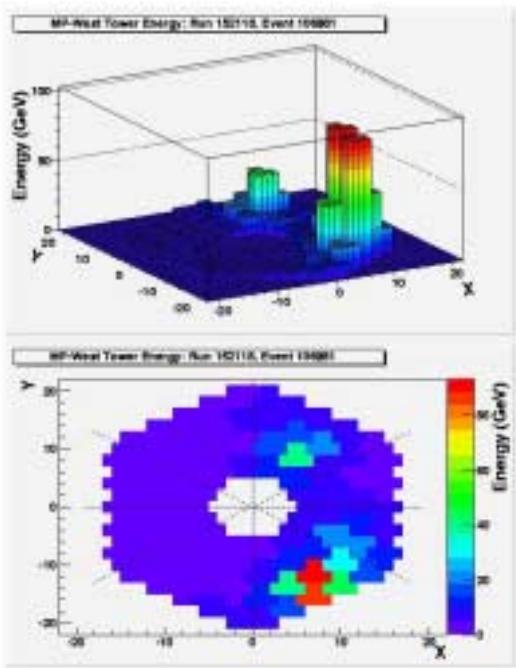
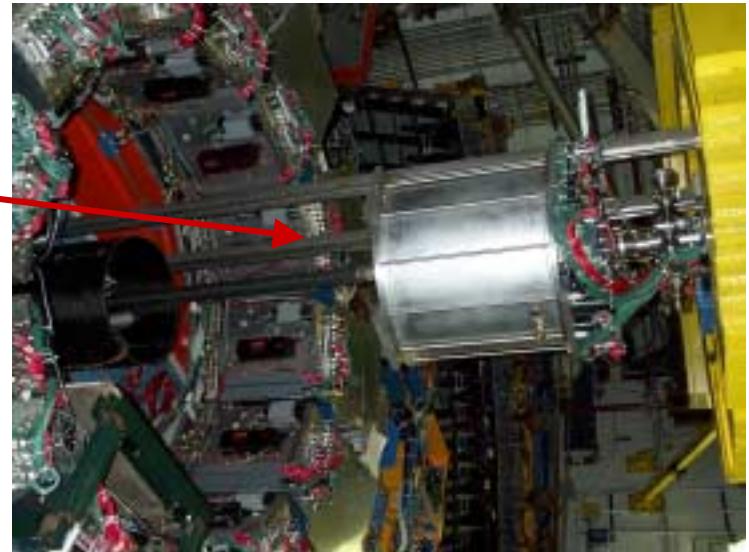


more precise measurement of forward jets



# New MiniPlug Calorimeter

- Liquid Scintillator + lead
- towerless geometry
- Full coverage:  $3.5 < |\eta| < 5.1$



Measure very forward jet energies